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TERRAIN STUDY

OF

HUNTER LIGGETT MILITARY RESERVATION CAMP ROBERTS

AND

HEARST ESTATE

Prepared by
535TH ENGINEER DETACHMENT (TERRAIN)
CORPS OF ENGINEERS, U. S. ARMY
ARMY MAP SERVICE
Washington 25, D. C.
1956

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TERRAIN STUDY

OF

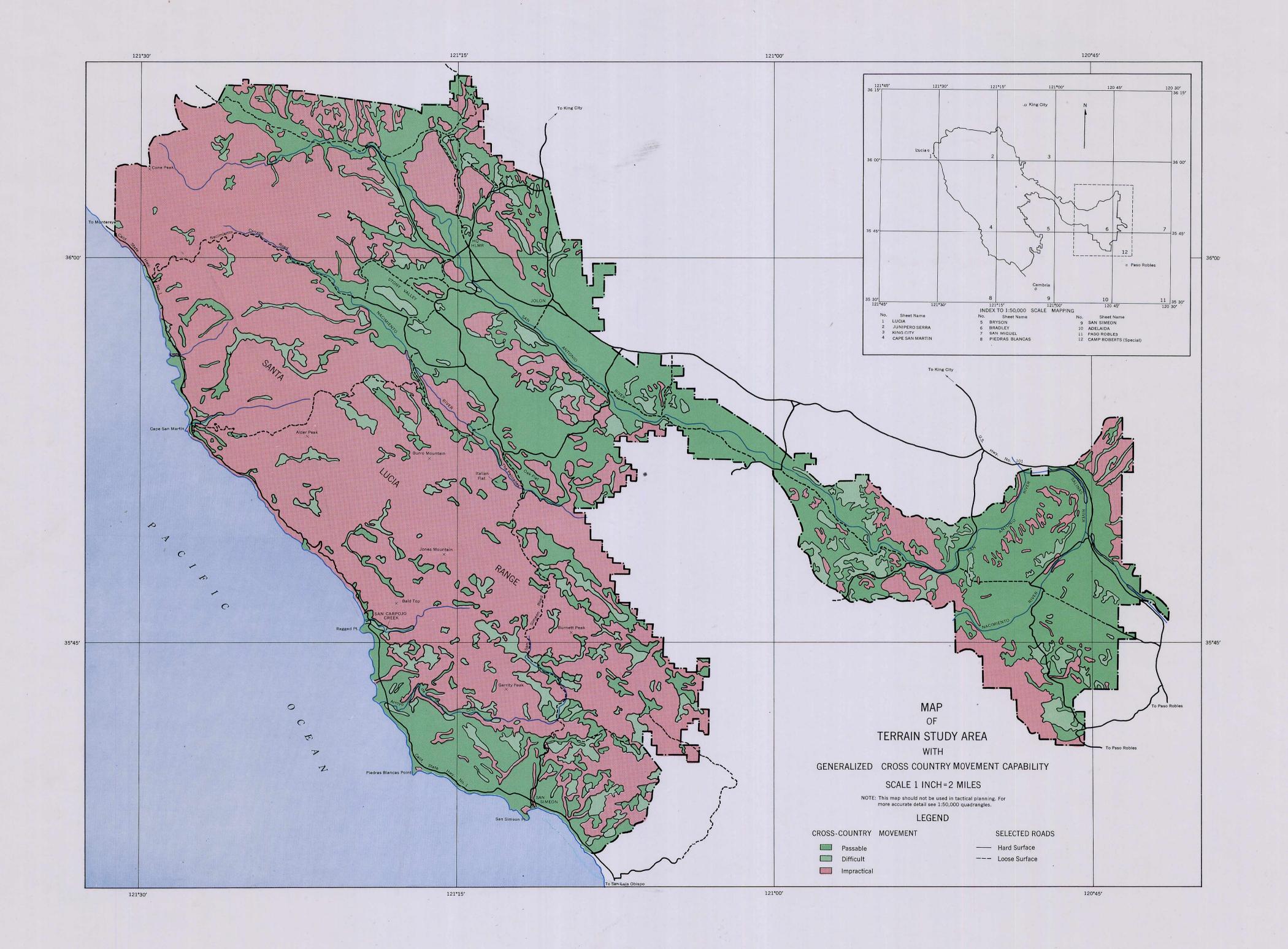
HUNTER LIGGETT MILITARY RESERVATION CAMP ROBERTS

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GENERAL TEXT

I. AREA OF STUDY

The area described in this report includes the Hunter Liggett Military Reservation, Camp Roberts, the Hearst Estate, and adjacent portions of the Los Padres National Forest. The area lies approximately midway between San Francisco and Los Angeles, about 45 miles south of Monterey. Included are portions of the central California Coast Range and its eastern foothills and parts of the Salinas Valley. The total area is about 590 square miles.

II. PURPOSE AND SCOPE

This report summarizes information on terrain conditions which would effect military operations in the study area. It includes data on the extent and condition of the existing road net; the distribution of vegetation types and their effect on military operations; and the feasibility of off-road movement of vehicles as controlled by slope, soil conditions, and vegetation. The report is based on published information, photo-interpretation, and field investigations.

III. GENERAL GEOGRAPHY OF THE AREA

A. Main Geographic Features

The major geographic feature and most important obstacle to cross country movement in the study area is the Santa Lucia Mountain Range, a part of the Coast Range mountain system. The Santa Lucia Range is a series of rugged, heavily vegetated ridges which trend roughly northwest-southeast, parallel to the coast. Steep-walled, deeply incised valleys cut both flanks of the range; west of the mountain crest the streams flow west or southwest and empty into the Pacific Ocean; east of the crest they flow east or southeast into the Nacimiento and San Antonio Rivers, both of which empty into the Salinas River. In the northern part of the area the crest of the Santa Lucia Range is over 5,000 feet in altitude within 3 miles of the coast. Farther south the crest is lower, between 3,000 and 4,000 feet above sea level.

The major portion of the coast is extremely precipitous, with cliffs as much as several hundred feet high, locally interrupted by short rocky beaches. South of the mouth of San Carpojo Creek a coastal low-land several miles wide occurs between the coast and the mountain front. All the ocean beaches suitable for major amphibious operations are located in this

East of the Santa Lucia Range are the broad, flat relatively open valleys of the Nacimiento and San Antonio Rivers, separated by low but rugged foothills, which trend northwest-southeast, parallel to the mountains. A second range of hills lies northeast of the San Antonio River Valley. These foothill ranges, because of their steep slopes and heavy cover of brush, form secondary obstacles to movement, channelizing all east-west movement through low gaps and along drainage lines. Movement along the San Antonio Valley and along that portion of the Nacimiento Valley between the Hunter Liggett boundary and the Palisades is relatively easy.

Camp Roberts lies in the Salinas Valley east of the easternmost foothills of the Santa Lucia Range. The topography is one of low barren hills transected by numerous small, intermittent streams tributary to the Salinas, San Antonio and Nacimiento Rivers. These rivers constitute the only significant natural obstacles and are not formidable except during periods of high water.

B. Road

Two primary north-south roads provide access to the study area: U.S. Route 101, in the Salinas Valley, and State Route 1, which parallels the coast.

There is an extensive secondary road network in the foothills and lowlands east of the Santa Lucia Range, but few roads connect this net with State Route 1 along the coast. Both U.S. 101 and State Route 1 are two-lane paved highways capable of supporting heavy duty traffic. The most direct east-west route from Hunter Liggett Military Reservation to the coast is the Nacimiento Road, which is capable of supporting one-way heavy duty traffic during dry weather. Only one road connects the Hearst Estate directly with Hunter Liggett Military Reservation. For this road to support continuous heavy duty traffic extensive bridge repair and road maintenance would be required.

C. Soils

The predominant soil types in the study area are silty sands, lean clays, and clayey sands. Silty sands are found in the broad valleys along the Nacimiento and San Antonio Rivers. Soils in these valleys and in some of the tributaries are composed of alluvial materials derived from the adjacent foothills and subsequently deeply weathered in place. The residual soils of the tributary valleys are largely silty sands, although small areas of clay and silty soils are common. In general, the silty sands have a very low plasticity and range from 40 to 70 percent sand. When wet these soils will not support continuous traffic.

The lean clays commonly occur east of the Santa Lucia Range along the small drainage features in the valleys and on the coastal lowlands in the Piedras Blancas and San Simeon quadrangles. Trafficability is better on the lean clays than on the silty sands. The coastal lowland consists of a series of clevated marine terraces, now largely mantled by alluvial fan deposits derived from the adjacent mountains. Both the marine deposits on the terraces and the overlying alluvial fan deposits have been deeply weathered in place.

The clayey sands are not extensive. They occur mainly east of the Santa Lucia Range in the smaller valleys and in higher areas within the larger river valleys. These soils are of medium plasticity with a sand content of between 35 and 60 percent.

Other soil types cover only small areas. The most important are the alluvial sands and gravels along the Nacimiento and San Antonio Rivers. These soils will support heavy traffic unless the poorly graded sands are saturated. Gravelly sands found in the river bottoms will support traffic even when

The only soils in the study area which will not support traffic when dry are the coastal dune sands. These sands are not extensive, but are of particular importance because of their location near landing beaches. They present a special problem in stabili-

D. Vegetation

In the lowlands and foothills east of the Santa Lucia Range and in some of the broad flat valleys within the range, the most common hardwood trees are deciduous oaks, mainly valley oak, blue oak, and Oregon white oak, growing in open stands with very little underbrush or as isolated trees in open grasslands. Digger pine is commonly associated with the oaks in this area, expecially in shallow rocky soils. Coast and interior live oak occur in the foothill belt, especially on moist northeast exposures, where they locally form dense stands.

Along streams, cottonwood, sycamore, and willow are the predominate species. In contrast to the open stands of oak in the same area, underbrush associated with the cottonwood-sycamore-willow stands is locally

very dense; it consists mainly of huckleberry, toyon, willow saplings, and wild rose.

On the eastern slopes of the Santa Lucia Range the forest trees are mainly non-deciduous oaks (chiefly valley live oak, coast live oak, and canyon live oak), California laurel, and tanbark oak. Madrone is an important component of the forest at higher elevations. Along streams sycamore, willow, and alder comprise the chief species. Cottonwood is not generally found in the mountains.

In a narrow belt along the crest of the range the forest consists of Ponderosa pine associated with madrone, black oak, and occasionally with sugar pine and Douglas fir. In this belt pure open stands of Ponderosa pine are common. The forests of the west flank of the Santa Lucia Range are composed of non-deciduous oaks, madrone, and California laurel, with dense stands of redwood occurring in valleys and on moist lower slopes as far south as the central part of the Cape San Martin quadrangle. Along streams sycamore, willow, alder, and big-leaf maple are predominant. In the San Simeon quadrangle dense stands of Monterey pine and eucalyptus are present.

In the coastal lowlands of the San Simeon quadrangle and in a few broad valleys within the mountains open stands of deciduous oaks similiar to those east of the Santa Lucia Range are encountered.

Various species of brush, known collectively as chapparel, cover extensive areas in the Santa Lucia Mountains and in the foothills to the east. The chief components are chemise, manzanita, ceanothus, and several species of scrub oak. Digger pine is commonly associated with the chapparel.

On the eastern slopes of the Santa Lucia Range chemise, ceanothus, and scrub oak are predominant, chemise commonly occurring on southwest slopes and ceanothus and scrub oak forming dense thickets in draws and on northeast slopes. At higher elevations scrub oak is less common and manzanita and madrone become prominent.

West of the crest of the range ceanothus is the predominant species, intermingled along the coastal slopes with laurel, which is dwarfed, apparently by constant winds.

E. Weather and Climate

East of the crest of the Santa Lucia Range the annual rainfall varies from about 10 inches in the extreme eastern portion of the study area to approximately 40 inches in the mountains. In pockets on the western slopes of the range annual precipitation amounts to about 60 inches. A mean annual isohyetal map covering the study area, together with a table showing average monthly distribution of rainfall appears on the following page. Mean monthly precipitation at five stations is also shown.

Mean monthly temperatures at Paso Robles vary from a minimum of 43.1 degrees in January to a maximum of 72.5 degrees in August, with a yearly mean of 58.0 degrees. Extremes recorded in 1955 at this station were 111 degrees on 1 September and 19 degrees on 7 January. The average temperature in 1955 was 0.6 degree below normal.

Variation at Piedras Blancas Point is from a low monthly mean of 49.1 degrees in January to a high monthly mean of 57.0 degrees in October. This station recorded extremes in 1955 of 84 degrees on 8 November and 32 degrees on 1 April. Average 1955 temperature was 0.8 degree below normal.

F. Drainage

The major streams in the area of study are the Nacimiento and San Antonio Rivers, both tributaries of the Salinas River. The two rivers flow generally parallel and in a southeast direction to their confluence with the Salinas River, in the north portion of Camp Roberts. The Salinas then flows northwesterly, emptying into the Pacific Ocean north of Monterey, California.

During the dry season, 15 April to 15 November, there is little or no flow in most of the streams in the area. The Salinas, Nacimiento, and San Antonio Rivers, though flowing most of the year, have no surface flow at times.

Mean monthly stream flow in cubic feet per second for the Nacimiento and San Antonio Rivers is shown on bar graphs on the following page.

In December, 1955, the study area, along with the rest of northern and central California, experienced its heaviest rainfall of record. This produced the highest stream discharge of record on 23 December as shown:

Drainage Area (Square miles)	Discharge 1/ (Cubic feet per second)
354	58,600
282	14,500
41	17,700
	(Square miles) 354 282

1/ 1 cfs = 450 gpm = 2 acre feet per day
2/ The Arroyo de la Cruz empties directly
into the Pacific Ocean about 10 miles north of
San Simeon.

IV. EXPLANATION OF THE MAPS

Three separate maps of each quadrangle are presented in this report: a cross-country-movement map, a vegetation map, and a map showing road and bridge classification. These maps are designed so that they may be reproduced as black and white overlays if necessary.

A. Cross-Country-Movement Maps

The cross-country-movement maps present information on slopes, vegetation, and soil conditions as they affect off-road movement of vehicles with performance characteristics of the M-47 tank. The maps are intended to serve as a guide for operational planning; they should not be used as a substitute for local reconnaissance.

Three terms are used to describe cross-country movement conditions:

Passable: In areas rated as passable slope and vegetation do not constitute obstacles to movement of vehicles and soil conditions will permit essentially unlimited traffic and maneuvering.

Difficult: In areas rated as difficult because of soil conditions slope and vegetation do not constitute obstacles to cross-country-movement, but soils will permit only a few passes of vehicles in trace and limited maneuvering.

In areas rated as difficult because of vegetation limited visibility and/or close trunk spac-

ing seriously impede movement of vehicles.

Impractical: In areas rated as impractical slope, vegetation, soil conditions, or a combination of these factors generally render movement of vehicles impossible.

Areas shown in dark green on the cross-country-movement map are passable during the dry season (15 April to 15 November; during the wet season (15 November to 15 April) most of these areas become difficult or impractical. The following table summarizes the predicted trafficability characteristics of various soils in these areas during the wet season:

Coarse grained poorly graded sands (SP)	A	Passable
Inorganic clays (CH, CL) Clayey sands (SC) Silty Clays (CL)	A ₁	Difficult
Silty sands (SM) Inorganic silts (ML) Clayey silts (ML) Very fine sands (ML) Clayey silts (CL-ML) Micaceous silts (MH)	A ₂	Impractical

In areas shown in light green on the cross-country-movement maps dense vegetation renders movement difficult during the dry season. Because of soil conditions, movement in these areas generally becomes impractical during the wet season.

Red indicates areas where steep slopes (over 45%), dense vegetation, or extremely rocky or broken topography make movement impractical at all times.

Areas outlined by heavy black dashed lines have very poor drainage. Fine-grained soils in these areas may not be sufficiently dry to support traffic for as long as 45 days after the end of the wet season. When the surface of these soils drys a crust forms which appears to be capable of supporting vehicles. However, because of the high moisture content of the underlying soil, these areas should be carefully investigated before movement across them is attempted.

Trafficability of some of the areas shown as difficult or impractical because of dense vegetation may be considerably improved by burning.

One important consideration should be kept in mind when using the cross-country-movement maps:

Immediately following rains trafficability of well drained soils will improve more rapidly than that of poorly drained soils. At these times, it will be better to choose routes through well drained areas in preference to more poorly drained areas regardless of soil conditions indicated on the cross-country-movement maps.

B. Vegetation Maps

The vegetation maps show principal types of vegetation cover as they affect concealment of personnel and equipment and cross-country movement.

Only the physical characteristics of vegetation are considered in the vegetation maps; species of trees and shrubs present are not indicated, as this information is not necessary for most military purposes. Four principal units are distinguished: (I) open areas, such as grasslands, fields and areas of sagebrush; (II) Open woodland and combinations of grassland and scattered trees; (III) dense woods; and (IV) brush, chiefly chapparel.

The canopy cover, that is, the percentage of an area covered by vegetation ten feet or more above the ground, was estimated from aerial photographs. Ground visibility and effect of each type of vegetation on cross-country movement was estimated in the field.

In many areas vegetation types are intermingled or occur in a mosaic of subdivisions too small to map individually. In these areas only the predominent type is indicated on the map and, where possible, the presence of other types is indicated by a note.

C. Road and Bridge Maps

The road and bridge maps indicate the existing road net, location and type of bridges, and the location of fords, and locked gates. The roads are classified as to width of traveled way, type of road, and load carrying capacity. The bridge information includes the total length, roadway width, overhead clearance, type of construction, and bypass condition.

The road types classification used is taken from FM 5-36, "Route Reconnaissance and Classification". The following types of roads are distinguished:

All-weather (X-type) road: Any road which, with reasonable maintenance, is passable throughout the year to a volume of traffic never appreciably less than its maximum dry-weather capacity. This type of road has a waterproof surface and is affected only slightly by rain, frost, thaw, or heat.

Limited all-weather (Y-type) road: Any road which with reasonable maintenance, can be kept open in bad weather to a volume of traffic which is considerably less than its maximum dry-weather capacity. This type of road does not have a water-proof surface and is considerably affected by rain, frost, or thaw. Traffic may be completely halted for a day or so at a time. Heavy use during adverse weather conditions may lead to complete failure of the road.

Fair-weather (Z-type) road: A road which quickly becomes impassable in bad weather and which cannot be kept open by normal maintenance. This type of road is affected so seriously by rain, frost, or thaw that traffic is brought to a complete halt for long periods.

Several Z-type roads which are impassable during bad weather conditions and only passable to light, mobile vehicles during favorable weather conditions are designated by a different symbol

as shown in the amo

as shown in the map legend. These roads, in addition to having a natural earth surface, have several of the following substandard qualities: grades in excess of 15 percent, roadway widths averaging less than 10 feet, radii of curvature less than 30 feet, deep ruts, and sections subject to landslide and washout.

Most of the firebreaks in the mountainous portion of Hunter Liggett Military Reservation are impassable to vehicles because of steep gradients. Usable firebreaks are shown on the map only where few other

GENERAL TEXT

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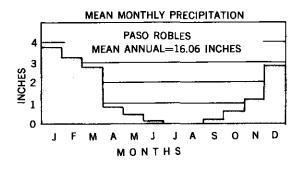
Vegetation

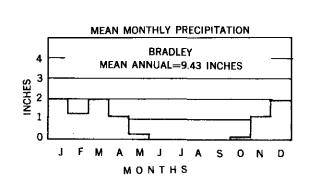
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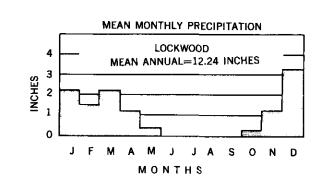
Roads and Bridges

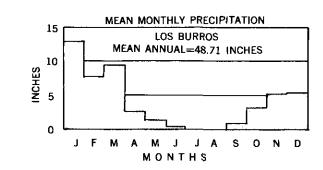
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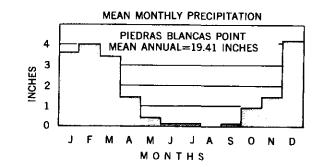


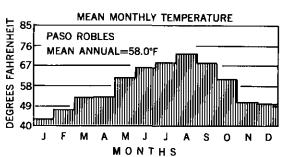


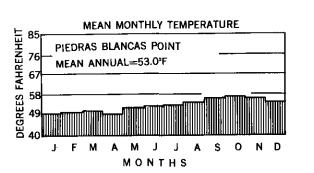


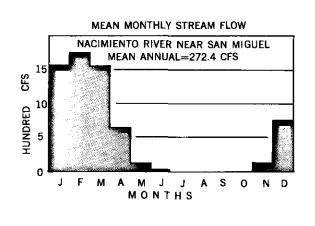


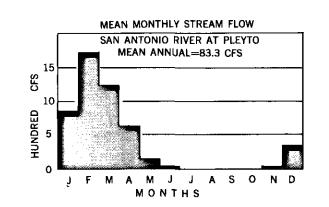




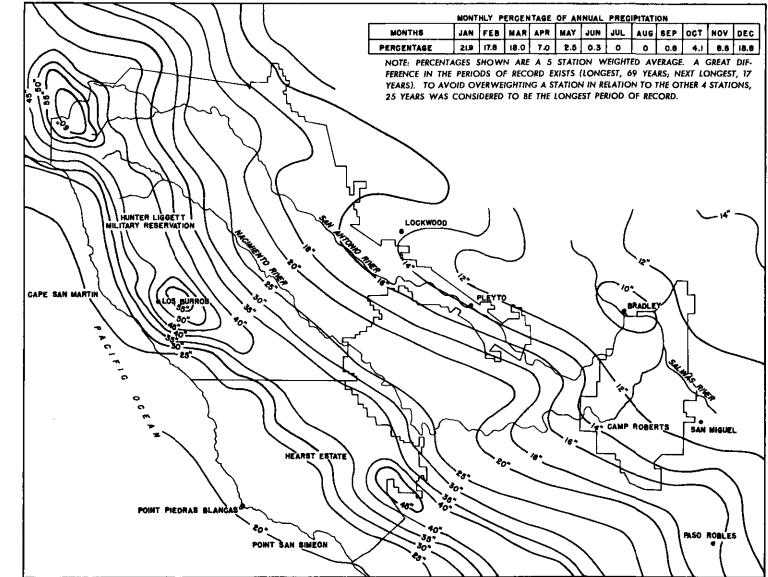




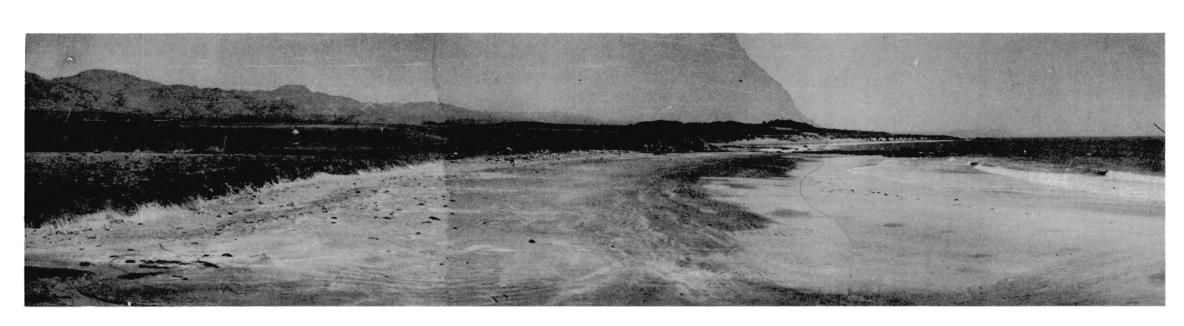




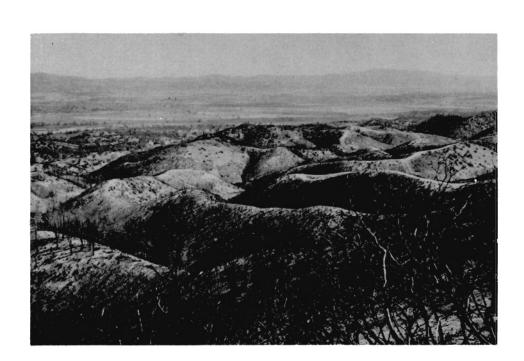
MEAN ANNUAL ISOHYETALS



GROUND PHOTOGRAPHY - GENERAL



Coastal lowland near San Simeon. View east from mouth of Oak Knoll Creek, San Simeon Quadrangle.



San Antonio Valley and neighboring foothills. View northeast from hill south of Oro Fino canyon, Bryson quadrangle.



Sea cliff and mountains north of mouth of San Carpojo Creek, Cape San Martin quadrangle.



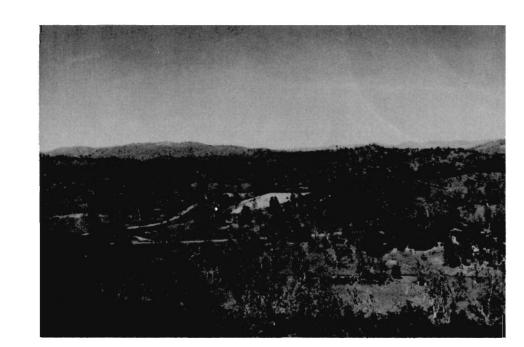
Typical terrain on northeast flank of Santa Lucia Range. View southeast from near Bound Spring, Cape San Martin quadrangle.



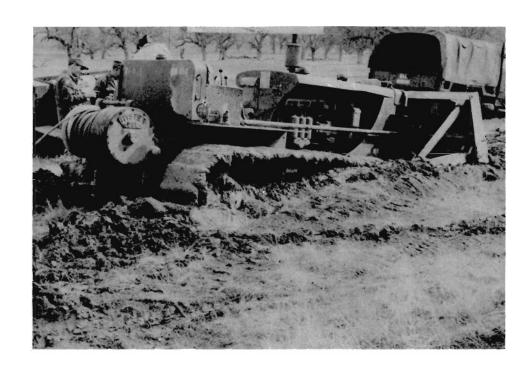
Coastal lowland and mountain front between Arroya Laguna and Arroyo del Cruz, San Simeon quadrangle.



Nacimiento River valley southwest of the Palisades, Bryson quadrangle.



Typical terrain in valley of El Piojo Creek, Bryson quadrangle.



D-8 stuck on first pass in saturated area, Oak flat, Bryson quadrangle, 28 Jan 1955.

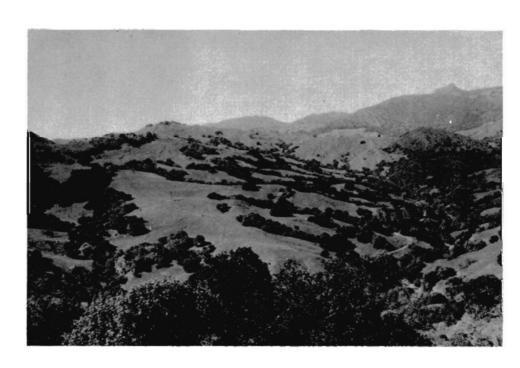


Vehicles stuck in saturated soil in Stony Valley, Bryson quadrangle, 20 Feb 1955.

GROUND PHOTOGRAPHY - VEGETATION



Decideous oaks in open stands east of the Palisades, Bryson quadrangle. (Unit IIA1)



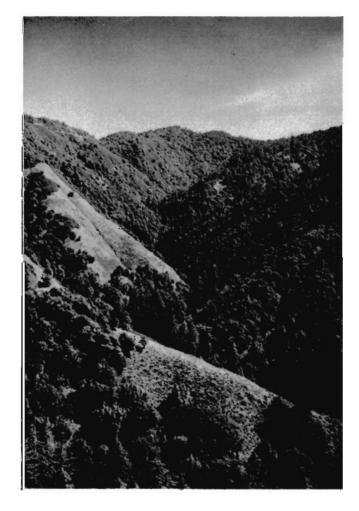
View up valley of Burnett Creek, San Simeon quadrangle showing live oak along gullies. (Unit IIA2)



Deciduous oaks in open stand in San Antonio River valley near Jolon, Bryson quadrangle. (Unit IIB1)



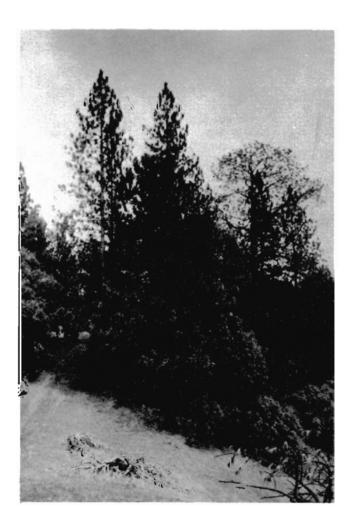
Redwood in valley on west flank of Santa Lucia Range, Cape San Martin quadrangle. (Unit III)



Valley on west side of Santa Lucia Range, Cape San Martin quadrangle. Redwoods in valley; live oaks, madrone, and California laurel on NE (right) slope; chemise on SW (left) slope. (Units III and IV)



Typical stand of chemise (foreground) and manzanita (background) on ridge top near Italian flat, Bryson quadrangle. White object is 12 inches high. (Unit IV)



Open stand of Ponderosa pine, madrone, and manzanita near crest of Santa Lucia Range, Cape San Martin quadrangle. (Unit IIB1)



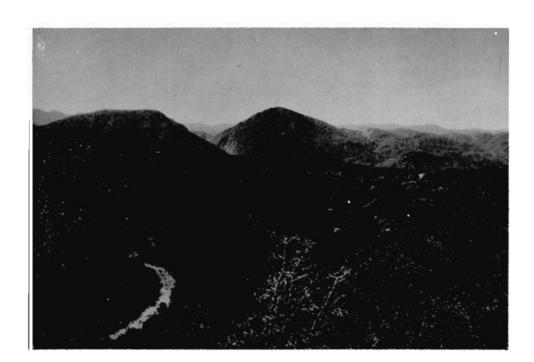
Open brush in area where extremely rocky condition prohibits movement of vehicles, SE of Oak Flat, Bryson quadrangle. (Unit IVA)



Typical scrub oak on NE slope near Italian Flat, Bryson quadrangle. White object is 12 inches high. (Unit IV)



Typical chemise associated with Digger pine on west side of Mission Creek Valley, Junipero Serra quadrangle. (Unit IV)



Chapparel in Santa Lucia Range NW of Italian Flat, Bryson quadrangle. (Unit IV)



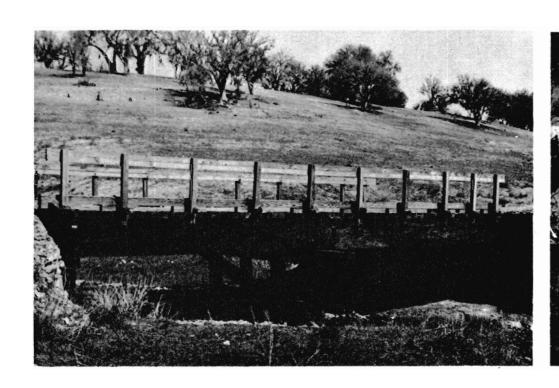
Brush in hills NE of Sam Jones Canyon, Bryson quadrangle. Chemise in foreground and on hilltop on left, ceantohus on left (SW) slope, scrub oak in valley bottom and on right (NE) slope. (Unit IV)



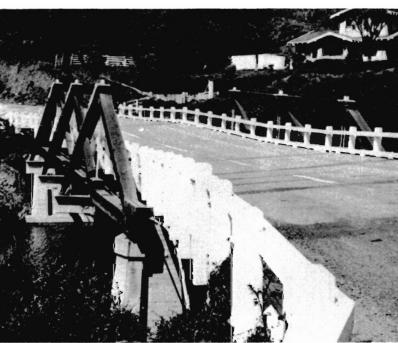
Chemise following a severe brush fire in impact area. Brush on skyline was not burned. SW of Jolon, Bryson quadrangle. (Unit IV)

GROUND PHOTOGRAPHY - VEGETATION

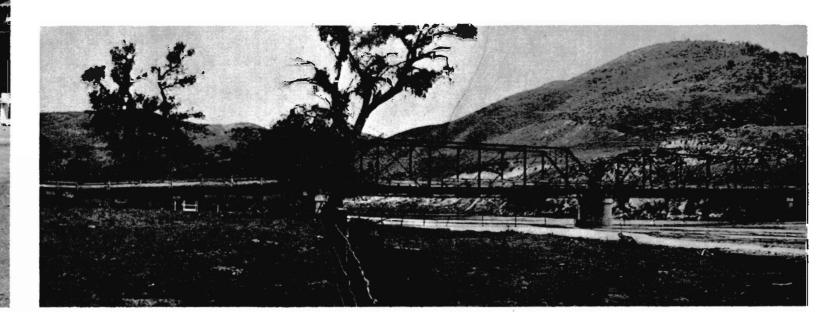
GROUND PHOTOGRAPHY - BRIDGES



Typical wood trestle bridge found on Hunter Liggett Military Reservation east of Santa Lucia Range. Bryson quadrangle. UTM 641782.



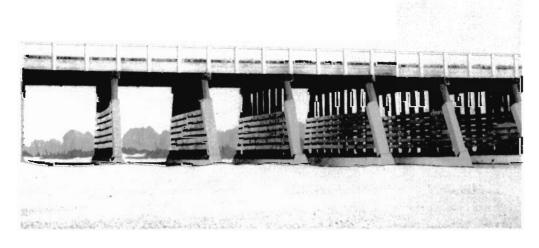
Wood truss bridge spanning San Carpajo Creek on Route 1. Bridge has sagging roadway. Cape San Martin quadrangle. UTM 520590.



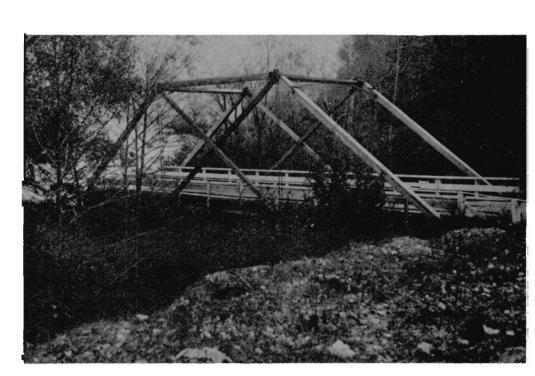
Low capacity steel truss bridge over San Antonio River. Bradley quadrangle. UTM 812707.



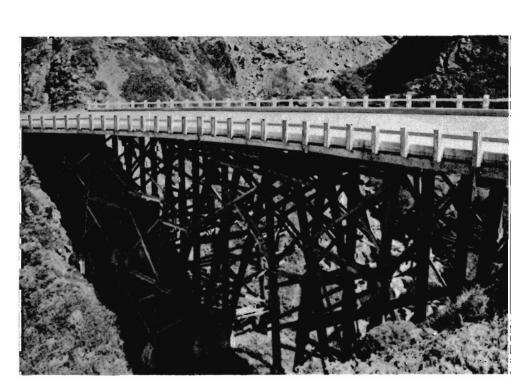
Bridge over Nacimiento River in Camp Roberts. Consisting of 65 concrete supports and wood flooring. Bradley quadrangle. UTM 998619.



H Street bridge spanning Nacimiento River in Camp Roberts. Bradley quadrangle. UTM 025654.



Low capacity wood truss bridge on Nacimiento Road. Junipero Serra quadrangle. UTM 424865.



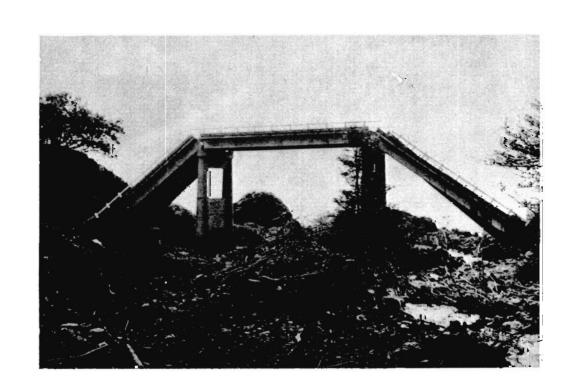
Bridge spanning Villa Creek. Wood trestle construction is typical of the majority of the bridges along Route 1. Cape San Martin quadrangle. UTM 439683.



Single lane temporary bridge on Route 1. Cape San Martin quadrangle. UTM 423694.



Substructure of temporary bridge on Route 1. Cape San Martin quadrangle. UTM 423694.



Washed out bridge over Mill Creek on Route 1. Cape San Martin quadrangle. UTM 362829.

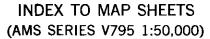


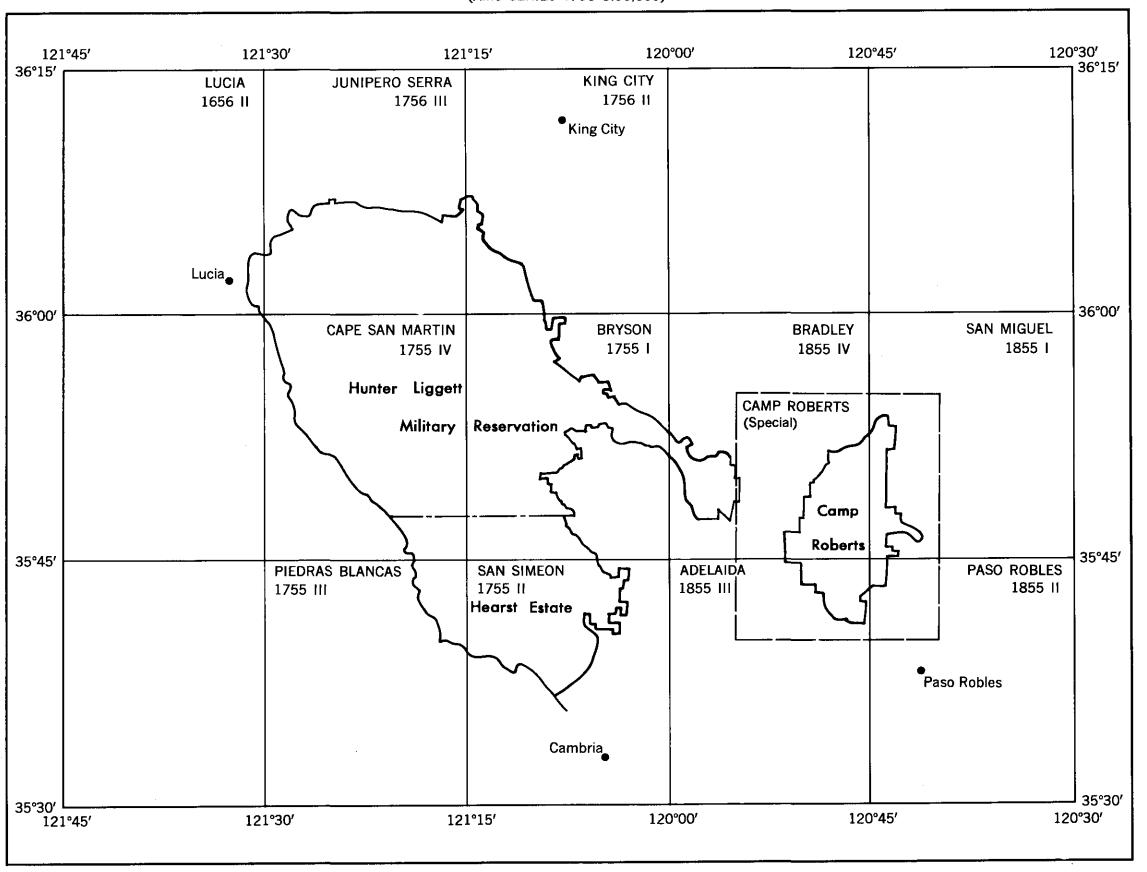
Wood trestle bridge on Hearst Estate-Hunter Liggett Road. Intermediate posts are not resting on the ground. San Simeon quadrangle. UTM 655523.

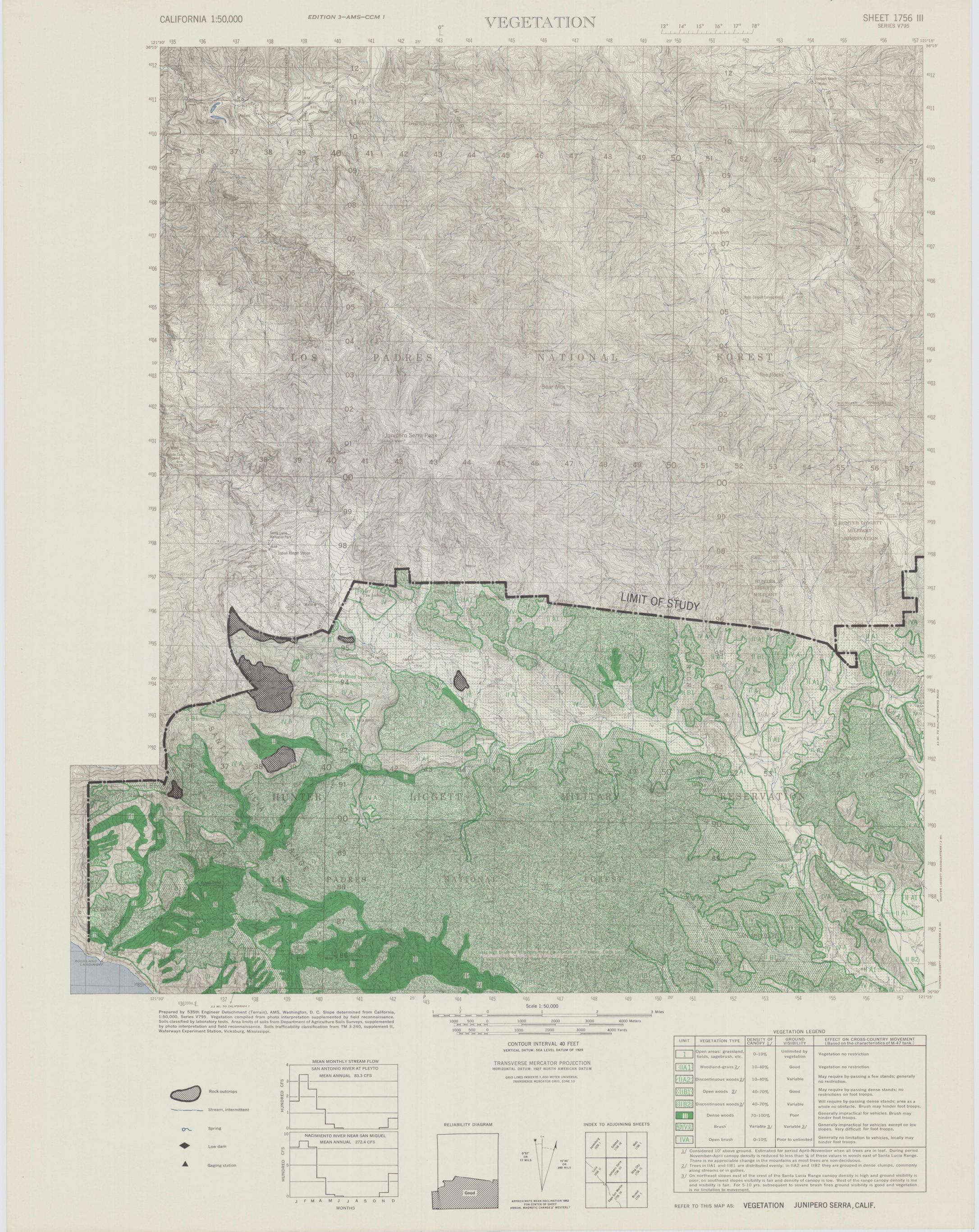


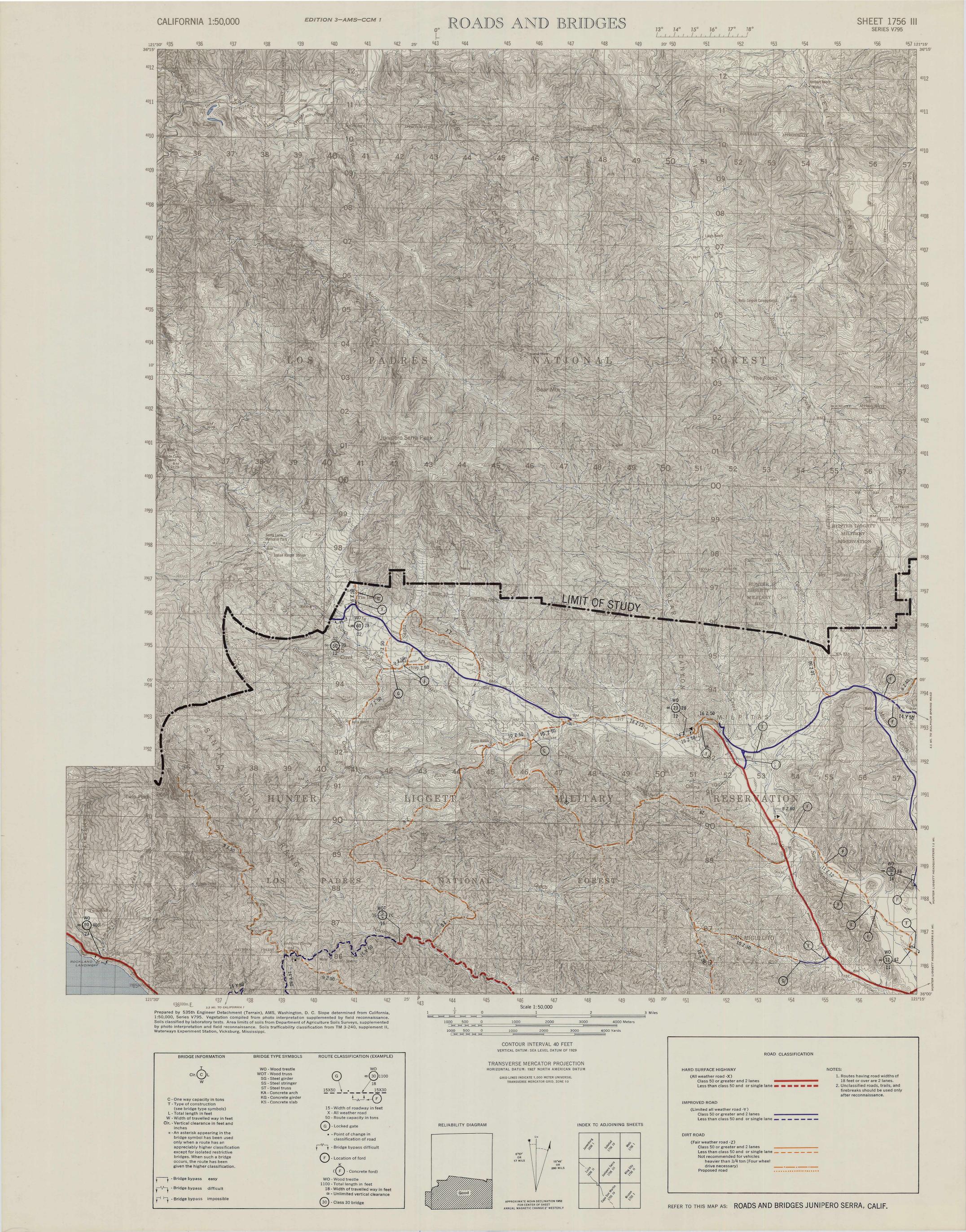
Substructure of bridge over Oak Knoll Cr on Route 1. Wood posts show signs of rotting at water line. San Simeon quadrangle. UTM 613470.

TERRAIN STUDY OF HUNTER LIGGETT MILITARY RESERVATION CAMP ROBERTS AND HEARST ESTATE









Map not available – not included in this book.

